

# KENNECOTT'S COMMENTS ON THE ECONOMIC ANALYSIS OF THE EPA MINE WASTE REPORT

## Introduction

In late December of 1985, the U.S. Environmental Protection Agency (EPA), issued a report to Congress on the subject of mining wastes.<sup>1</sup> This report was prepared in response to the requirements of Sections 8002 (f) and (p) of the Resource Conservation and Recovery Act (RCRA). This report is voluminous (286 pages in length), and both broad and detailed in scope. For example, 17 metals-producing segments (e.g., copper, gold, iron, lead, mercury, etc.) and 2 nonmetal industry segments (asbestos and phosphate) of the mining industry are addressed. The EPA Mine Waste Report contains an overview of the industry, estimates of waste volumes, a description of present and alternative waste treatment methods, an identification of wastes that may present a danger to human health and the environment, an analysis of problems at inactive or abandoned mining sites, and other relevant topics. One chapter (Chapter 5 MWR) in this report evaluates the possible cost impacts of alternative sets of mine waste regulatory assumptions. This chapter is based largely on work performed by an EPA contractor, Charles River Associates Incorporated (CRA).<sup>2</sup>

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<sup>1</sup>U.S. EPA, Office of Solid Waste, Wastes From The Extraction and Benefication of Metallic Ores, Phosphate Rock, Asbestos, Overburden From Uranium Mining, and Oil Shale, 31 December 1985, hereinafter, EPA Mine Waste Report or MWR in page citations.

<sup>2</sup>Charles River Associates, Final Report: Estimated Costs to the U.S. Mining Industry For Management of Hazardous Solid Waste, CRA Report No. 730, August 1985, hereinafter, CRA report or CRA in page citations.

### Scope Of These Comments

This document summarizes Kennecott's preliminary comments on the economic analyses contained in the EPA Mine Waste and CRA Reports. The word "preliminary" should be underscored. These reports merit careful and extensive analysis. Moreover, as EPA evaluates oral and written comments on these reports and studies the matter of mine waste regulation further, it is to be expected that additional, and more concrete, regulatory alternatives will be considered. Kennecott is vitally concerned with the subject of mine waste regulation and will continue to provide constructive input to EPA's decision whether to regulate mine wastes and, if so, how to structure these regulations. These comments are restricted to the copper segment of the domestic mineral industry.

### General Comments

Before advancing to specifics, it is appropriate to offer some general comments on the economic analysis.

First, it is important to note that although the phrase "economic analysis" is used in the report, the principal contents of this analysis are limited to calculations of the costs of various regulatory alternatives. A cost analysis is a necessary and important first step in the conduct of an economic analysis. But mere calculation of costs does not provide a decision-maker with either an accurate or a comprehensive picture of the potential impacts of alternative regulatory strategies. For example, evaluation of such important quantities as resultant mine or mill closures, employment losses, price changes, or international trade and competitiveness effects are beyond the scope of a cost analysis.<sup>3</sup> A focus on cost analysis, although arguably satisfying a narrow interpretation of the study

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<sup>3</sup>These omissions are acknowledged (MWR pp 5-1, et seq.), but no reason is offered for this limited focus. It is difficult to justify this limitation in view of the current administration's concern over trade deficits and international competitiveness (see Global Competition, The New Reality, The Report of the President's Commission on Industrial Competitiveness, January 1985, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.).

mandate (MWR p. 1-2, p. 1-5), seems inconsistent with Congressional instruction to perform a "detailed and comprehensive" study of mine wastes. If, as might be argued, economic factors are totally subordinate to the objectives of protection of human health or the environment, why did Congress specifically direct an "analysis of the cost of these alternatives in terms of the impact on mine product costs" (MWR p. 1-2) or of "the impact of these alternatives on the use of phosphate rock and uranium ore, and other natural resources" (emphasis added, MWR p. 1-5)? Technicalities aside, a comprehensive economic analysis -- which should include such topics as trade and competitiveness effects as noted above -- is central to the development of a rational regulatory approach. Kennecott recommends that these issues be explored by EPA in the upcoming months.

Second, it is important to emphasize that the EPA and CRA cost analyses are "tentative, since they are based on only a sampling of sites, very general engineering cost evaluations, and various hypothetical regulatory scenarios" (MWR p. 5-1). Although logically more refined cost estimates could prove either higher or lower than those given in the reports, our attempts to replicate these cost estimates using site-specific data for Kennecott facilities together with our interpretation of what would be required under the alternative regulatory scenarios have generally resulted in higher costs than are given in the CRA report -- a point discussed later in the text. The lack of detail with respect to some key aspects of the CRA cost analysis may explain discrepancies in estimated costs, but there is reason to believe that the costs associated with certain scenarios are understated.

Finally, as noted below, several regulatory scenarios are evaluated in the report. Some of these alternatives specify less stringent controls than are presently applicable to hazardous waste facilities (full Subtitle C regulation) -- a laudable attempt by EPA to be responsive to Congressional intent to provide flexibility to the EPA Administrator in choosing whether and, if so, how to regulate mining wastes. For example, the

Conference Report accompanying H.R. 2867 (which in its final amended form was passed by both Houses of Congress as P.L. 98-616) provides clarification;

"This Amendment recognizes that even if some of the special study wastes (which include mining wastes as specified in Sections 8002(f) and (p)) are determined to be hazardous it may not be necessary or appropriate because of their special characteristics and other factors, to subject such wastes to the same requirements that are applicable to other hazardous wastes. The authority delegated to the Administrator under this section is both waste-specific and requirement-specific. The Administrator could also exercise the authority to modify requirements for different classes of wastes. Should these wastes become subject to the requirements of Section 3005(j), relating to the retrofit of surface impoundments, the Administrator could modify such requirements so that they are not identical to the requirements that are applied to new surface impoundments containing such wastes. It is expected that before any of these wastes become subject to regulations under subtitle C, the Administrator will determine whether the requirements of Section 3004(c), (d), (e), (f), (g), (o), and (u), and Section 3005(j) should be modified." (H.R. Report 98-1133, pp. 93-94, October 3, 1984; emphasis added.)

an expression of Congressional intent acknowledged in the EPA report (MWR, pp. 1-7, ES-1, ES-2, 1-5). Although the impacts of even these "low cost" scenarios are very significant, we believe that EPA's willingness to consider more flexible alternatives is to be commended.

The remainder of these comments address more specific and detailed points relevant to the economic analysis. First, a brief summary of the principal findings of the EPA and CRA reports relative to the copper segment is presented.

### Regulatory Scenarios

CRA considered eight different sets of regulatory assumptions, termed "scenarios" in the report. There were four principal regulatory scenarios, termed "full Subtitle C" (Scenario 1), "tailored Subtitle C" (Scenario 2), "Corrective Action" (Scenario 3), and "Basic Maintenance and Monitoring" (Scenario 4), respectively. Brief qualitative descriptions of these scenarios are provided in Table 1, and a somewhat more detailed identification of specific actions required under each of these regulatory assumptions is included in Table 2.

In addition to these principal scenarios, two sets of assumptions were made as to the possible scope of mine waste regulation. In the first set, termed set "A", the scope was limited only to those wastes which satisfy current RCRA listing criteria because of EP

TABLE I.  
SCENARIO IDENTIFICATION PER CRA

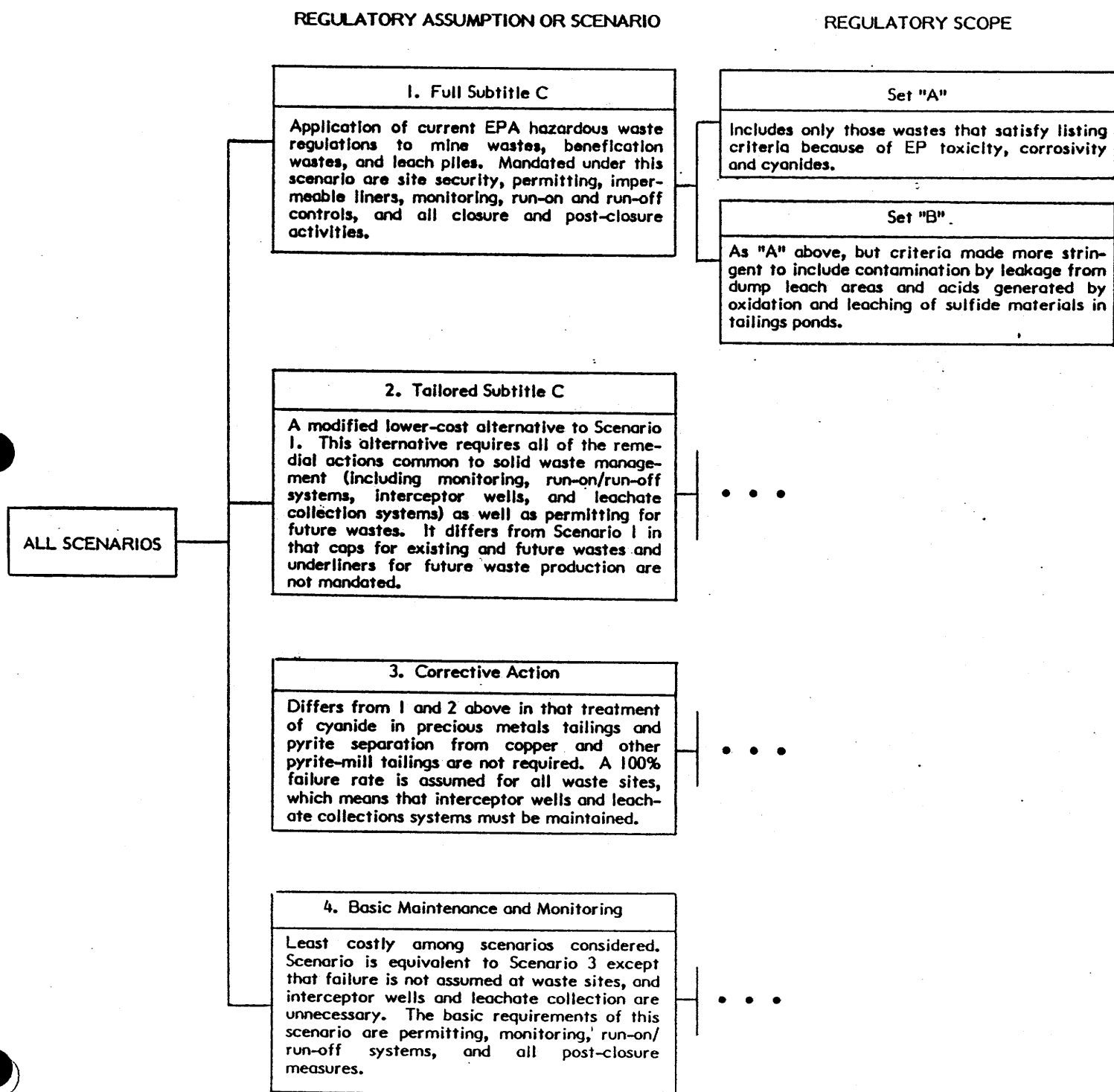


TABLE 2.  
SUMMARY OF REQUIRED COST ITEMS UNDER VARIOUS RCRA COMPLIANCE SCENARIOS

Cost Item	Full Subtitle C			Tailored Subtitle C			Corrective Action as Required		
	Heap & Dump			Heap & Dump			Heap & Dump		
	Mine Ore Waste	Leaching Waste	Mill Tailings	Mine Ore Waste	Leaching Waste	Mill Tailings	Mine Ore Waste	Leaching Waste	Mill Tailings
<b>Existing Waste</b>									
Site Security	x	x	x						
Permitting									
Impermeable Liner									
Leachate Collection Ditches	x	x	x	x	x	x	x	x	x
Monitoring System	x	x	x	x	x	x	x	x	x
Run-on and Run-off Systems	x			x			x		
Interceptor Wells	x	x	x	x	x	x	x	x	x
Closure (Capping)	x	x	x						
Postclosure O&M	x	x	x	x	x	x	x	x	x
<b>Future Waste</b>									
Site Security	x	x	x						
Permitting	x	x	x	x	x	x	x	x	x
Impermeable Liner	x	x	x						
Leachate Collection Ditches				x	x	**	x	x	x
Monitoring System	x	x	x	x	x	x	x	x	x
Run-on and Run-off Systems	x			x			x		
Tailings Treatment*			x(?) <sup>a</sup>			**			
Interceptor Wells					x	x**	x	x	x
Closure (Capping)	x	x	x	x					
Postclosure O&M	x	x	x	x	x	x	x	x	x

\* Assuming a 10 percent probability under full Subtitle C for existing Waste and 0 percent probability for future waste.

\*\* Assuming a flotation circuit is installed to separate a pyrite concentrate and a treatment plant is installed to destroy the cyanide in the mill tailings prior to disposal in a tailings pond. The cost of leachate collection and interceptor wells will be zero for future waste.

<sup>a</sup>Not given in CRA report, but presumably required.

Source: Charles River Associates, July 1985.

toxicity, corrosivity, and cyanides. An alternative and more stringent set, the "B" set, broadened the scope of the mine waste regulatory program to include contamination by leakage from dump leach areas and potential acid formation by oxidation and leaching of sulfide materials in tailings ponds. Sets "A" and "B" were evaluated for each of the four principal regulatory scenarios, so that a total of eight options was examined.

### CRA Cost Calculations

Although the exact cost estimation procedure is not fully documented in the CRA report, in outline it was accomplished as follows:

- (i) a regulatory scenario (e.g., 1A, 1B, 2A, etc.) was assumed,
- (ii) each of the mines in a specially developed data base was examined and necessary activities/actions/equipment identified,
- (iii) cost estimating relationships (CERs) were developed to estimate the capital and operating costs of each item that might be required. For example, the equation used to calculate the capital cost (in \$ thousands) of pyrite tailings flotation was (CRA p. 42) estimated from the equation,  
$$\text{Cost} = 60 (\text{tons waste per year})^{0.7}$$

Depending upon the regulatory scenario and site-specific data (e.g., whether pyrite tailings were present), the cost of this and other items was included or omitted, and

- (iv) costs for each mine were added to estimate total copper industry costs. Various economic cost calculations such as present values, annualized costs, and unitized costs (i.e., costs expressed per unit of product) were also made.

The specific mines included, assumed cost items required at each mine under each scenario, the estimated mine-by-mine costs, and other inputs to cost calculations are not presented in CRA's report. Therefore, it is not possible to replicate the cost computations exactly.

### Cost Impacts

CRA's estimated cost impacts on the domestic copper industry are summarized in Table 3. For example, referring to Table 3, the total lifetime (undiscounted) costs

TABLE 3.  
COST IMPACTS OF ALTERNATIVE REGULATORY SCENARIOS  
ON THE COPPER INDUSTRY ACCORDING TO CRA

Scenario	Scope					
	A			B		
	Lifetime Costs (\$MM)	Annualized Costs (\$MM/yr)	Unit Cost <sup>a</sup> cents/lb Cu	Lifetime Costs (\$MM)	Annualized Costs (\$MM/yr)	Unit Cost <sup>a</sup> cents/lb Cu
1	1,400	110	80	8,300	740	55
2	350 <sup>b</sup>	14	10	2,400	150	11
3	380 <sup>c</sup>	14	10	1,500	59	4.5
4	42	2.2	1.6	220	11	0.8

<sup>a</sup>For affected facilities.

<sup>b</sup>Reported as \$400 MM in EPA report.

<sup>c</sup>Should logically be equivalent to 2A, possible misprint in report.

Source: CRA report various tables.

associated with Scenario IB are estimated as \$8.3 billion, equivalent on an annualized basis to \$740 million per year or to an average of 55 cents per pound for "affected" facilities (CRA p. 28).

Attempts to replicate these computations for Kennecott facilities and resulting discrepancies are discussed in a later section. It is useful, however, to examine CRA's estimates further.

Table 3 shows a substantial variation in all cost measures among the regulatory scenarios considered by EPA. For example, in terms of costs per pound of copper per affected facility, these costs ranged from slightly less than 1 cent (Scenario 4B) to 80 cents (Scenario 1A). Most of the cost estimates are quite high; in six of the eight scenarios the cost per pound is 4.5 cents or larger and for Scenarios 1A and IB the costs are 80 and 55 cents respectively.

CRA computed both average costs, such as are shown in Table 3, and "maximum costs" for those facilities with the greatest volume of waste or "especially difficult management conditions" (MWR p. 5-18). It was noted that costs for the maximum cost facility were significantly higher than average -- higher by a factor of three in some cases. Because there was so much variability in the cost estimates, the use of average costs could be misleading. The distribution of these costs among facilities was not presented in the CRA report, so these effects are not considered in the comments here.

### Cost Impacts In Perspective

For the most part, the EPA Mine Waste Report and the CRA report are silent on the matter of economic impacts of these incremental costs. Some sense of the significance of these incremental costs is conveyed in the EPA Mine Waste Report by calculations of these costs as a percentage of direct costs of mine product and asides to the effect that "the additional effects of regulation on some segments of the mining industry could be

substantial" (e.g., MWR p. ES-16, p. 5-14). But, as noted in the general comments above, there is no attempt to translate these cost impacts into meaningful economic terms.

For some scenarios, particularly Scenarios 1A and 1B, the costs to the copper industry are so large that no economic analysis is required. These regulations would simply eliminate any affected facility. Copper prices are determined by the world balance between supply and demand and not set unilaterally by U.S. producers. Any attempt by U.S. producers to raise domestic copper prices to cover incremental costs of this magnitude would result in an abrupt loss of market share as other world copper producers not similarly burdened (e.g., those in Canada, Chile Mexico, Peru, Zaire, or Zambia) would simply sell into the U.S. market at the current market price (about 65 cents per pound as of this writing) and undercut U.S. producers.

Even the lower cost scenarios (e.g., Scenarios 2A, 2B, 3A, 3B) with average incremental unitized costs for affected facilities between 4.5 and 11 cents per pound would result in substantial facilities closures.

To see this, note first from Table A-1 (contained at the end of these comments) that estimated long run supply elasticities for price responsive producers, such as those in the U.S. and Canada, are typically greater than unity (the median value of United States and Canada long run supply elasticities is about 1.5 and the mean value is substantially higher -- more than 6). What this means is that the percentage decrease in supply associated with a 1% decrease in price or equivalently a 1% increase in cost is from 1.5% to 6% or more. Based on these assumptions an across-the-board 5 cents per pound cost increase (7.7% of current prices) could idle from 10% to 40% of domestic copper mine output.<sup>4</sup>

This general magnitude of supply effect is supported by data from the Minerals Availability System of the U.S. Bureau of Mines (USBM) given in Table 4. This table

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<sup>4</sup>For the "B" scenarios, the percentage of "affected" facilities was close to 100%, so across-the-board increases were used here. For the "A" scenarios, the percentage of "affected" facilities was smaller, and this will reduce the estimates of idle capacity made in this section. Kennecott has not made these adjustments for the "A" scenarios because no mine-by-mine data are included in the CRA report.

TABLE 4.  
USBM ESTIMATES OF DOMESTIC COPPER PRODUCTION  
COSTS AND CAPACITY POINT TO HIGHER RCRA IMPACTS

<u>Production Cost Range (cents/lb)</u>	<u>Annual Capacity In This Cost Range (000 MT)</u>	<u>Cumulative Capacity At This Or Lower Cost (000 MT)</u>
Below 60	273	273
60 - 65	284	557
66 - 70	416	973
71 - 75	73	1046
76 - 80	0	1046
81 - 85	258	1304
86 - 90	0	1304
91 - 100	60	1364

Source: Personal Communication, Minerals Availability, U.S. Bureau of Mines.

Notes: Costs shown are cash costs (e.g., excluding depreciation and profit). Costs are for 1984 and given in \$ 1984.  
Costs are based on a sample of 16 major mines in 1984 -- including both operating and shut-down mines. 1984 production was approximately 1 million metric tons; this is consistent with the hypothesis that cash costs of producing mines ranged up to 70 cents per pound.

shows the latest available (1984<sup>5</sup>) data on the aggregate capacity of mines that could produce copper at the indicated cash costs.<sup>6</sup> (Both operating and inactive mines are included in the USBM sample). For example, at a cash cost of 70 cents per pound, 973,000 metric tons (MT) of copper could be produced annually. Suppose now that incremental costs of 5 cents per pound were imposed. The only mines that could produce copper at a breakeven level are those with current costs of 65 cents or lower, or (from Table 3) mines with an aggregate capacity of 557,000 MT, a 43% output reduction compared to the base case.<sup>7</sup>

No estimates are given here for the impact of regulation on domestic copper reserves. However, EPA should be aware that additional regulatory costs reduce the domestic copper reserve base.

Because both elasticity values and the USBM capacity curve are dated, we present the above as illustrative of possible capacity reductions attendant to RCRA regulation rather than specific forecasts. These estimates can be refined as new data become available. The important point of these examples is that, at present, the survival of many mines in the domestic copper industry hinges on small cost differentials, measured in pennies or fractions of a penny per pound of copper produced. This critical perspective is missing entirely in both the CRA and EPA reports.

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<sup>5</sup>These estimates are presently being revised, but the updated values are not yet available. For details, contact R. Rosenkranz, U.S.B.M. (303) 236-5202.

<sup>6</sup>i.e., exclusive of depreciation or profit.

<sup>7</sup>Some economists may question adding a unitized cost (5 cents/pound in this example) which includes capital cost recovery to cash costs which don't include capital recovery. However, before the fact, any company making a decision to commit the necessary additional investments for RCRA compliance would tend to regard existing capital costs as sunk costs and base a decision solely on recovery of the incremental capital investments. After the fact, of course, the incremental capital cost for RCRA would be "sunk" and operating levels would be determined by cash costs. A similar convention is followed by CRA which expresses unitized costs as a percentage of present direct costs.

A reader, dulled by what appears to be a constant litany of predictions of dire economic consequences to the copper industry if additional environmental costs were imposed, might ask, "Will it ever be so?" Kennecott cannot answer this question conclusively. The short-term copper price outlook is relatively flat or, at best, calls for modest price appreciation.<sup>8</sup> However, the domestic copper industry has made substantial progress in cost reduction in the past few years. Kennecott specifically has announced a major modernization program to upgrade its Utah facility and other firms in the industry are reportedly considering additional investments. If implemented, these measures will further increase the competitiveness of the domestic industry.

#### Comparison With Alternative Cost Estimates

Earlier it was noted that it was difficult to replicate the CRA computations because not all computational assumptions were made explicit in the CRA report. For example, it was not stated exactly which mines were in the data base, nor what cost items were assumed necessary at each mine for each regulatory scenario, nor what site-specific factors (such as the size of tailings ponds, estimated annual waste volumes, etc.), were used as inputs to the CERs. Nonetheless, it is important to verify some of these cost computations -- at least as to order-of-magnitude.

Our initial attempts at verification suggest that CRA cost estimates for at least some scenarios may be understated -- perhaps significantly. As one test case, Kennecott has made several sets of cost calculations applicable to its Utah facility. This facility houses both a mine-mill combination and a copper leaching facility. It is among the largest copper mines in the world, but otherwise can be thought of as more or less typical. Thus, although on a facility basis the costs of the RCRA regulation might be higher than at other copper mines, expressed on a unitized cost basis the costs should be

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<sup>8</sup>Some analysts, including those at Phelps Dodge, are predicting that COMEX prices might reach 70-75 cents per pound by the summer of 1986 (Metals Week, March 24, 1986, p. 1), but this is a minority opinion at present.

comparable. Indeed, to the extent that economies of scale are present in the CERs developed by CRA (true for some cost elements such as tailings flotation and interceptor wells, for example), unitized costs at Utah might be expected to be somewhat lower than at smaller copper mines.

The first comparison made is summarized in Table A-2, attached. This represents the full Subtitle C requirements on the expanded set of waste criteria or Scenario IB. Because Utah's mine tailings are pyritic, and thus (MWR p. 4-49) would be classed as having acid formation potential, tailings treatment is assumed to be required. Impermeable liners are assumed to be required for newly disposed tailings and dump leach wastes -- new waste areas are assumed to be equal in size to present waste areas. In fact, it would be very difficult to locate these facilities within the existing Utah complex. (Kennecott has argued elsewhere that some of the Subtitle "C" requirements are technically impossible to achieve. For cost calculation purposes these are assumed possible. However, if in fact relocation of say the tailings pond were required, additional costs not included here would be imposed.)

Notwithstanding that the methodology in Table A-2 is likely to understate costs, the costs given in Table A-2 approach the fantastic. Total capital costs for this facility alone exceed \$12 billion, well in excess of CRA's estimate of lifetime costs for the entire copper industry.

An examination of the individual cost estimates shows that tailings treatment accounts for approximately \$10 billion of this total. Either the CER for this cost element is in error (as given in CRA p. 42) or there are typographical errors in the CRA report. Certainly tailings treatment (given these costs) cannot be viewed as a less expensive alternative to other measures as is implied in descriptions of modified Subtitle "C" scenarios.

Even if this cost element is excluded -- although some allowance should be made for this cost in any event -- as shown in Table A-3, the lifetime costs at Utah are approximately 41% of CRA's estimate for the entire industry. "Scaling up" this estimate to an

industry total would lead to a figure substantially higher than that estimated by CRA. Calculated unit costs per pound are higher than CRA's industry estimate by a factor of 41%, assuming 80% capacity utilization at the Utah facility.

Cost discrepancies were noted for other scenarios, although these were generally more modest than the above examples indicated.

Kennecott has not made any exhaustive independent evaluation of the accuracy of the CERs presented in the CRA report, nor independent estimates of costs under any of the regulatory scenarios specified in the report using other than the CERs given in the CRA report. However, even casual inspection of the CERs used by CRA suggests that the cost associated with certain items are understated. For example, Kennecott's cost estimate for purchase and installation of monitoring wells is approximately \$15,000 each, whereas the capital cost used in the CRA report (CRA, p. 41, item 5) is \$5,000 each. Considering that (according to the well spacing specified in the CRA report) as many as 94 wells might be required at Utah (66 if overburden dumps do not need to be monitored), this cost difference alone is nearly \$1 million in capital cost for this item at only one facility. Kennecott will have occasion to cross-check other CRA cost estimates in the following months.

#### Implications of the "Derived From" Rule Neglected

Finally, it is appropriate to note that none of the costs estimated in the EPA or CRA reports address cost impacts on "downstream" processing as a result of regulatory decisions on mine wastes. For example, under the "derived from" provision of RCRA (Section 261.3 (ii) (iii), (c)(2) and (d)(2)) and full Subtitle "C" provisions, copper produced from pregnant leach liquors would become a listed waste if this process stream were listed, as called for in the "B" scenarios. Smelters and refineries treating this "waste" would then become RCRA hazardous waste treatment facilities entailing additional cost impacts not included in the EPA or CRA reports. Kennecott has not made cost calculations, but it is clear that these cost impacts would be material.

TABLE A-1.  
A SAMPLING OF PRICE ELASTICITY OF SUPPLY ESTIMATES  
RANKED IN INCREASING ORDER OF ABSOLUTE VALUE

Price Elasticities

<u>Short-Term</u>	<u>Long-Term</u>	<u>Market Addressed</u>	<u>Years Included</u>	<u>Comments</u>	<u>Reference</u>
0.02	1.25	Zaire	1953-1979		CRA (1980).
0.0684	NE	Zambia	1955-1957, 1961-1965	Supply from mine production.	Fisher, <i>et al.</i> , (1972), p. 578.
0.07	0.25	Zambia	1960-1976 $R^2=0.832$		Obidegwu, C.F. and M. Uziram Asanga, "Copper and Zambia", p. 47-48, Lexington Books, 1981.
0.07	0.18	Zaire	1950-1967	Refined copper production.	Banks (1969).
0.09	1.5	Peru	1953-1979		CRA (1980).
0.10	1.23	Canada	1950-1967	Refined copper production.	Banks (1966).
0.10	NE	World	1955-1979		Lonoff (1981).
0.10	3.69	Zaire	1950-1967	Mine production simple least squares estimation method.	Banks (1969).
0.112	0.402	Chile	1948-1968	Supply from mine production.	Fisher, <i>et al.</i> (1972), p. 577.
0.114	0.18	Chile		Gran Minería	Lexington Books, 1981, M. Lasaga, p. 33, "The Copper Industry in the Chilean Economy."
0.13*		Chile	Unspecified	Supply from mine production.	Burrows and Lonoff (1977), p. 23.
0.135	3.3	Rest-of-world (excluding Eastern Bloc, Chile, and Zambia).	1953-1979		CRA (1980).
0.14	0.66	Chile		Medium and Small Mines	Lexington Books, 1981, M. Lasaga, p. 33, "The Copper Industry in the Chilean Economy."
0.15	0.71	Peru	1950-1967	Refined copper production. The coefficient of price term is not significantly different from 0.	Banks (1969).
0.16-0.3 with 0.2 most likely	NE	Market world minus CIPEC.	Unspecified	Supply from mine production.	Takeuchi (1972), p. 12.

\*Term not specified.  
NE = Not Estimated.

TABLE A-1.  
A SAMPLING OF PRICE ELASTICITY OF SUPPLY ESTIMATES  
RANKED IN INCREASING ORDER OF ABSOLUTE VALUE  
(continued)

Price Elasticities

<u>Short-Term</u>	<u>Long-Term</u>	<u>Market Addressed</u>	<u>Years Included</u>	<u>Comments</u>	<u>Reference</u>
0.16	3.03	Canada	1949-1963	Three pass least squares.	Newhouse and Sloan (1966), as stated in Takeuchi, p. 19.
0.17	20	Canada	1953-1979		CRA (1980).
0.1726	0.625	Zaire	1948-1967	Supply from mine production only.	Banks (1974), p. 119.
0.18	42.24	Canada	1950-1967	Mine production using simple linear least squares estimation method.	Banks (1969).
0.18	0.37	Chile	1950-1967	Refined copper production.	Banks (1969).
0.188	14.84	Canada	1948-1967	Supply from mine production.	Fisher, <i>et al.</i> , (1972), p. 578.
0.1963	1.68	Rest-of-market (That is, the world's copper suppliers excluding the Eastern-bloc countries and the United States, Chile, Zambia, and Canada, for which separate estimates were made.)	1948-1968	Supply from mine production.	Fisher, <i>et al.</i> (1972) P. 579.
0.2	2.47	World (excluding CPE's).	1949-1963	Using ordinary least squares estimation method.	Newhouse and Sloan (1966), as cited in Takeuchi, p. 19.
0.2	6.18	World (excluding CPE's)	1949-1963	Using three pass least squares estimation method.	Newhouse and Sloan (1966), as cited in Takeuchi, p. 19.
0.2-0.4	NE	Market world minus CIPEC.	Unspecified	Mine production including secondary refined copper (i.e., scrap).	Takeuchi, (1972), p. 12.
0.22	1.44	Chile	1950-1967	Mine production. Using simple linear least squares estimation method.	Banks (1969) as cited in Takeuchi, p. 19.
0.23	2.41	Canada	1947-1963	Ordinary least squares.	Newhouse and Sloan (1966) as stated in Takeuchi, p. 19.
0.23	2.41	Chile	1947-1963	Ordinary least squares.	Newhouse and Sloan (1966) as stated in Takeuchi, p. 19.
0.23	0.95	Chile	1950-1967	Refined copper production. Estimate reflects a lag of one year in the price term. Moreover, the coefficient of the price term is not significantly different from 0.	Banks (1969).

NE = Not Estimated

TABLE A-1.  
A SAMPLING OF PRICE ELASTICITY OF SUPPLY ESTIMATES  
RANKED IN INCREASING ORDER OF ABSOLUTE VALUE  
(continued)

Price Elasticities

<u>Short-Term</u>	<u>Long-Term</u>	<u>Market Addressed</u>	<u>Years Included</u>	<u>Comments</u>	<u>Reference</u>
0.2365	1.16	Canada	1948-1967		Banks (1974), p. 119.
0.25	0.71	United States	1950-1967	Mine production simple least squares.	Banks (1969).
0.27	NE	United States	1953-1979		CRA (1980).
0.28	0.61	United States	1972-1974	Supply from mine production.	CRA (August 1976), p. 77.
0.289	1.22	Chile	1948-1967	Supply from mine production only.	Banks (1974), p. 119.
0.3	1.0	United States	1947-1965	Ordinary least squares.	Newhouse and Sloan (1966), as stated in Takeuchi, p. 19
0.3	1.3	United States	1948-1965	Three pass least squares.	Newhouse and Sloan (1966), as stated in Takeuchi, p. 19.
0.31	0.63	United States	1948-1967		Banks (1974), p. 119.
0.36		Canada	1958-1975	Supply from mine production.	Burrows and Lonoff (1977), P. 17.
0.36	8.91	Chile	1947-1963	Three pass least squares.	Newhouse and Sloan (1966), as stated in Takeuchi, p. 19.
0.42	3.41	Peru	1950-1967	Mine production. Simple least squares estimation method.	Banks (1969), as cited in Takenchi, p. 19.
0.45	1.67	United States	1949-1958	Estimates refer to primary copper or mine production. Some years were omitted to eliminate the effect of major copper strikes in the United States.	Fisher, <u>et al.</u> , (1972), p. 577.
0.47	0.77	United States	1950-1967	Refined copper production.	Banks (1969).
0.542	1.93	Peru	1948-1967	Supply from mine production only.	Banks (1974), p. 119.
0.8	1.9	United States	1924-1939	Three pass least squares estimation method.	Newhouse and Sloan (1966), as cited in Takeuchi, p. 19.
1.0	1.9	United States	1922-1939	Using ordinary least squares estimation method.	Newhouse and Sloan (1966), as cited in Takeuchi, p. 19.
NA	At least 0.7 and probably above 1.0	World minus CIPEC.	Unspecified	Not including secondary copper.	Takeuchi (1972), p. 26.

NE = Not Estimated

TABLE A-2  
RCRA WASTE COSTS AT KENNECOTT'S FACILITIES  
BASED UPON THE CRA COST ESTIMATING MODELS

FILE: EXP

FACILITY: UTAH

ASSUMPTION: FULL SUBTITLE "C" REQUIREMENTS

DESCRIPTION: THIS RUN CALCULATES THE COST OF FULL SUBTITLE "C" REQUIREMENTS AT KENNECOTT'S UTAH FACILITY. IN THIS RUN IT IS ASSUMED THAT MINE WASTE--i.e., OVERBURDEN--IS NOT CLASSIFIED AS HAZARDOUS, BUT THAT LEACH DUMPS AND TAILINGS ARE CLASSIFIED AS HAZARDOUS--LEACH DUMPS BECAUSE THESE ARE LISTED AND TAILINGS BECAUSE OF THE POTENTIAL FOR ACID FORMATION. IT IS ASSUMED THAT SPACE IS AVAILABLE TO REPLICATE THE EXISTING WASTE DUMPS AND THAT NEW DUMPS OF THE SAME SIZE ARE USED. TAILINGS TREATMENT IS ASSUMED.

## INITIAL INPUTS AND PRELIMINARY CALCULATIONS:

GENERIC	SPECIFIC ITEM	VALUE	UNITS	REMARKS/SOURCE
AREAS:	MINE WASTE	1985 ACRES		R. A. MALONE TESTIMONY 11 MARCH 1986, WASHINGTON, D.C.
	LEACH DUMPS	2110 ACRES		R. A. MALONE TESTIMONY 11 MARCH 1986, WASHINGTON, D.C.
	TAILINGS	5500 ACRES		R. A. MALONE TESTIMONY 11 MARCH 1986, WASHINGTON, D.C.
PERIMETERS:	MINE	55500 LINEAR FT.		PLANIMETER DETERMINATION FROM MINE MAPS
	LEACH DUMPS	60500 LINEAR FT.		PLANIMETER DETERMINATION FROM MINE MAPS
	TAILINGS	71280 LINEAR FT.		PERIMETER CALCULATED AT BASE OF TAILINGS POND
OTHER:	MONITOR WELL	500 FT INTERVAL		BASED ON DOWNGRAIDENT PERIMETER
	HEADS GRADE	0.69 % Cu		FROM SUTULOV
	CONC. GRADE	25 % Cu		UTAH DATA
	Cu IN LEACH	20000 TONS/YEAR		AT CAPACITY
	Cu IN CONC.	185000 TONS/YEAR		AT CAPACITY
	UTILIZATION	80 % CAPACITY		NOMINAL VALUE FOR UNITIZED COST COMPUTATIONS
	RECOVERY	0.9 FRACTION		FROM SUTULOV
CALCS:	MONITOR WELL	28 WELLS		# MONITOR WELLS REQD. AT MINE IF HAZARD EXISTS
	MONITOR WELL	30 WELLS		# MONITOR WELLS REQD. AT LEACH DUMP IF HAZARD EXISTS
	MONITOR WELL	36 WELLS		# MONITOR WELLS REQD. AT TAILINGS POND IF HAZARD EXISTS
	CONCENTRATES	740000 TONS/YEAR		FROM Cu AND CONCENTRATE GRADE
	MILL FEED	29790660 TONS/YEAR		FROM MATERIAL BALANCE
	WT. TAILINGS	29050660 TONS/YEAR		CALCULATED FROM CONCENTRATE THROUGHPUT
	PRODUCTION	205000 TONS/YEAR		TOTAL ANNUAL Cu CAPACITY

## ECONOMIC INPUTS:

INPUT	VALUE	UNITS	REMARKS
DEPRECIATION	15 YEARS		ASSUMED DEPRECIATION LIFETIME
INTEREST RATE	9 PERCENT		CRA ASSUMPTION
INT. FRACTION	0.09 FRACTION		CONVERSION OF INTEREST RATE TO DECIMAL
CRF	0.12406 FRACTION		STD. COMPUTATION OF CAPITAL RECOVERY FACTOR
MINE HORIZON	15 YEARS		ASSUMPTION IN CRA REPORT

PV CLOSURE	0.27454 FRACTION	PRESENT VALUE FRACTION FOR CLOSURE COSTS
PV ANNUITY	10.2737 FACTOR	PRESENT VALUE OF 30 YR. POST-CL. ANNUITY FOR PRESENT WASTE
PV POST-CL	2.8265 FACTOR	PRESENT VALUE OF 30 YR. POST-CL. ANNUITY FOR FUTURE WASTE
PERMIT COST	\$3.00 MILLIONS	DATA IN CRA REPORT

## COST CALCULATIONS FOR EXISTING WASTES:

ITEM DESCRIPTION	ASSUMED IN		ESTIMATED ANNUAL COST (\$MILLIONS)	CRA REPORT TABLE REFERENCE	REMARKS/BASIS
	THIS ANALYSIS (YES=1.0, NO=0)	ESTIMATED CAPITAL COST (\$MILLIONS)			
SITE SECURITY-MINE WASTE	0	\$0.000	\$0.000	TABLE A-2,1	OVERBURDEN AND ORE NOT HAZARDOUS
SITE SECURITY-LEACH DUMP	1	\$1.513	\$0.076	TABLE A-2,1	WASTE ASSUMED TO BE LISTED
SITE SECURITY-TAILINGS	1	\$1.782	\$0.089	TABLE A-2,1	TAILINGS HAVE ACID-FORMATION POTENTIAL
LEACHATE COLLECTION MINE	0	\$0.000	\$0.000	TABLE A-2,4.1	ASSUMED UNNECESSARY
LEACHATE COLLECTION LEACH	0	\$0.000	\$0.000	TABLE A-2,4.1	ASSUMED PRESENT IN BASE CASE
LEACHATE COLLECTION TAIL.	1	\$1.213	\$0.061	TABLE A-2,4.1	REQD. PER TABLE 3-5
LEACHATE TREATMENT MINE	0	\$0.000	\$0.000	TABLE A-2,4.1	
LEACHATE TREATMENT LEACH	1	\$1.481	\$0.405	TABLE A-2,4.1	REQD. PER TABLE 3-5
LEACHATE TREATMENT TAIL.	1	\$2.632	\$0.830	TABLE A-2,4.1	REQD. PER TABLE 3-5
MONITORING WELLS MINE	0	\$0.000	\$0.000	TABLE A-2,5	ASSUMED UNNECESSARY
MONITORING WELLS LEACH	1	\$0.150	\$0.193	TABLE A-2,5	REQUIRED
MONITORING WELLS TAILINGS	1	\$0.180	\$0.231	TABLE A-2,5	REQUIRED
RUN-ON SYSTEM M-WASTE	1	\$0.555	\$0.028	TABLE A-2,6	REQD. FOR ORE PILES ONLY
RUN-OFF-SYSTEM M-WASTE	1	\$0.555	\$0.028	TABLE A-2,7	REQD. FOR ORE PILES ONLY
INTERCEPTOR WELLS MINE	0	\$0.000	\$0.000	TABLE A-2,9	
INTERCEPTOR WELLS LEACH	1	\$5.984	\$1.593	TABLE A-2,9	ASSUMED TO BE REQUIRED
INTERCEPTOR WELLS TAIL.	1	\$9.878	\$3.008	TABLE A-2,9	ASSUMED TO BE REQUIRED
CLOSURE MINE WASTE	0	\$0.000	\$0.000	TABLE A-2,10	MINE WASTE NOT HAZARDOUS
CLOSURE LEACH	1	\$253.200	\$0.000	TABLE A-2,10	SPENT AT BEGINING
CLOSURE TAILINGS	1	\$660.000	\$0.000	TABLE A-2,10	SPENT AT BEGINING
POST-CLOSURE	1	\$0.000	\$14.307	TABLE A-2,11	SPENT FOR 30 YEARS FROM START

TOTAL OF ABOVE COSTS (\$MILLIONS)	\$939.123	\$14.307 ANNUAL COSTS ARE POST-CLOSURE ONLY
LIFETIME (\$MILLIONS)		\$1,368.33 INCLUDES CAPITAL AND 30 YR. POST-CLOSURE
ANNUALIZED COSTS (\$MILLIONS)		\$134.741 EVALUATED USING ABOVE ECONOMIC ASSUMPTIONS
UNITIZED COST CENTS/LB @ CAPACITY		32.86 INCLUDES OPERATING AND ANNUALIZED CAPITAL COSTS
@ NOMINAL UTILIZATION		41.08 APPROXIMATE VALUE

## COST CALCULATIONS FOR FUTURE WASTES:

ITEM DESCRIPTION	ASSUMED IN		ESTIMATED ANNUAL COST (\$MILLIONS)	CRA REPORT TABLE REFERENCE	REMARKS/BASIS
	THIS ANALYSIS (YES=1.0, NO=0)	ESTIMATED CAPITAL COST (\$MILLIONS)			

SITE SECURITY-MINE WASTE	0	\$0.000	\$0.000 TABLE A-2,1 OVERBURDEN AND ORE NOT HAZARDOUS
SITE SECURITY-LEACH DUMP	1	\$1.513	\$0.076 TABLE A-2,1 WASTE ASSUMED TO BE LISTED
SITE SECURITY-TAILINGS	1	\$1.782	\$0.089 TABLE A-2,1 TAILINGS HAVE ACID-FORMATION POTENTIAL
PERMITTING	1	\$3.000	\$0.000 TABLE A-1 RECD.
IMPERMEABLE LINER-M-WASTE	0	\$0.000	\$0.000 TABLE A-2,3.1OVERBURDEN AND ORE NOT HAZARDOUS
IMPERMEABLE LINER-LEACH	1	\$118.160	\$0.000 TABLE A-2,3.1WASTE ASSUMED TO BE LISTED
IMPERMEABLE LINER-TAILINGS	1	\$522.500	\$0.000 TABLE A-2,3.3ASSUMED
LEACHATE COLLECTION MINE	0	\$0.000	\$0.000 TABLE A-2,4.1UNNECESSARY
LEACHATE COLLECTION LEACH	0	\$0.000	\$0.000 TABLE A-2,4.1UNNECESSARY FOR FUTURE WASTES IF LINED
LEACHATE COLLECTION TAIL.	0	\$0.000	\$0.000 TABLE A-2,4.1UNNECESSARY FOR FUTURE WASTES IF LINED
LEACHATE TREATMENT MINE	0	\$0.000	\$0.000 TABLE A-2,4.1UNNECESSARY FOR FUTURE WASTES IF LINED
LEACHATE TREATMENT LEACH	0	\$0.000	\$0.000 TABLE A-2,4.1UNNECESSARY FOR FUTURE WASTES IF LINED
LEACHATE TREATMENT TAIL.	0	\$0.000	\$0.000 TABLE A-2,4.1UNNECESSARY FOR FUTURE WASTES IF LINED
MONITORING WELLS MINE	0	\$0.000	\$0.000 TABLE A-2,5 ASSUMED UNNECESSARY
MONITORING WELLS LEACH	1	\$0.150	\$0.193 TABLE A-2,5 REQUIRED
MONITORING WELLS TAILINGS	1	\$0.180	\$0.231 TABLE A-2,5 REQUIRED
RUN-ON SYSTEM M-WASTE	1	\$0.555	\$0.028 TABLE A-2,6 RECD. FOR ORE PILES ONLY
RUN-OFF-SYSTEM M-WASTE	1	\$0.555	\$0.028 TABLE A-2,7 RECD. FOR ORE PILES ONLY
TAILINGS TREATMENT	1	\$10,054.499	\$901.602 TABLE A-2,8 NECESSARY BECAUSE OF PYRITE CONTENT
INTERCEPTOR WELLS MINE	0	\$0.000	\$0.000 TABLE A-2,9
INTERCEPTOR WELLS LEACH	0	\$0.000	\$0.000 TABLE A-2,9 PER STATEMENT ON p-21
INTERCEPTOR WELLS TAIL.	0	\$0.000	\$0.000 TABLE A-2,9 PER STATEMENT ON p-21
CLOSURE MINE WASTE	0	\$0.000	\$0.000 TABLE A-2,10 MINE WASTE NOT HAZARDOUS
CLOSURE LEACH	1	\$284.850	\$0.000 TABLE A-2,10 SPENT AT END OF MINE HORIZON
CLOSURE TAILINGS	1	\$742.500	\$0.000 TABLE A-2,10 SPENT AT END OF MINE HORIZON
POST-CLOSURE	1	\$0.000	\$10.787 TABLE A-2,11 SPENT AFTER END OF MINE LIFE

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TOTAL OF ABOVE COSTS (\$MILLIONS)	\$11,730.244	\$913.034 TOTAL ANNUAL COSTS INCLUDE POST-CLOSURE
		ANNUAL COSTS WHICH NEED TO BE DISCOUNTED
LIFETIME (\$MILLIONS)		\$25,587.57 INCLUDES 15 YR. OPNS. & 30 YR. POST-CLOSURE
ANNUALIZED COSTS (\$MILLIONS)		\$2,268.801 EVALUATED USING ABOVE ECONOMIC ASSUMPTIONS
UNITIZED COST CENTS/LB @ CAPACITY		553.37 INCLUDES OPERATING AND ANNUALIZED CAPITAL COSTS
@ NOMINAL UTILIZATION		691.71 APPROXIMATE VALUE

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GRAND TOTAL: CAPITAL COSTS (\$MILLIONS)		\$12,669.37 FOR PRESENT AND FUTURE WASTES
LIFETIME COSTS(\$MILLIONS)		\$26,955.90 INCLUDED CAPITAL, OPERATIONS AND POST-CLOSURE
ANNUALIZED COSTS (\$MILLIONS)		\$2,403.54 EVALUATED USING ABOVE ECONOMIC ASSUMPTIONS
UNITIZED COST CENTS/LB @ CAPACITY		586.23 INCLUDES OPERATING AND ANNUALIZED CAPITAL COSTS
@ NOMINAL UTILIZATION		732.79 APPROXIMATE VALUE

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TABLE A-3  
RCRA WASTE COSTS AT KENNECOTT'S FACILITIES  
BASED UPON THE CRA COST ESTIMATING MODELS

FILE: EXP1

FACILITY: UTAH  
ASSUMPTION: FULL SUBTITLE "C" REQUIREMENTS WITHOUT TAILINGS TREATMENT

DESCRIPTION: THIS RUN CALCULATES THE COST OF FULL SUBTITLE "C" REQUIREMENTS AT KENNECOTT'S UTAH FACILITY. IN THIS RUN IT IS ASSUMED THAT MINE WASTE--i.e., OVERBURDEN--IS NOT CLASSED AS HAZARDOUS, BUT THAT LEACH DUMPS AND TAILINGS ARE CLASSED AS HAZARDOUS--LEACH DUMPS BECAUSE THESE ARE LISTED AND TAILINGS BECAUSE OF THE POTENTIAL FOR ACID FORMATION. IT IS ASSUMED THAT SPACE IS AVAILABLE TO REPLICATE THE EXISTING WASTE DUMPS AND THAT NEW DUMPS OF THE SAME SIZE ARE USED. NO TAILINGS TREATMENT IS ASSUMED

## INITIAL INPUTS AND PRELIMINARY CALCULATIONS:

GENERIC	SPECIFIC ITEM	VALUE	UNITS	REMARKS/SOURCE
AREAS:	MINE WASTE	1985 ACRES		R. A. MALONE TESTIMONY 11 MARCH 1986, WASHINGTON, D.C.
	LEACH DUMPS	2110 ACRES		R. A. MALONE TESTIMONY 11 MARCH 1986, WASHINGTON, D.C.
	TAILINGS	5500 ACRES		R. A. MALONE TESTIMONY 11 MARCH 1986, WASHINGTON, D.C.
PERIMETERS:	MINE	55500 LINEAR FT.		PLANIMETER DETERMINATION FROM MINE MAPS
	LEACH DUMPS	60500 LINEAR FT.		PLANIMETER DETERMINATION FROM MINE MAPS
	TAILINGS	71280 LINEAR FT.		PERIMETER CALCULATED AT BASE OF TAILINGS POND
OTHER:	MONITOR WELL	500 FT INTERVAL		BASED ON DOWNGRADIENT PERIMETER
	HEADS GRADE	0.69 % Cu		FROM SUTULOV
	CONC. GRADE	25 % Cu		UTAH DATA
	Cu IN LEACH	20000 TONS/YEAR		AT CAPACITY
	Cu IN CONC.	185000 TONS/YEAR		AT CAPACITY
	UTILIZATION	80 % CAPACITY		NOMINAL VALUE FOR UNITIZED COST COMPUTATIONS
	RECOVERY	0.9 FRACTION		FROM SUTULOV
CALCS:	MONITOR WELL	28 WELLS		# MONITOR WELLS REQD. AT MINE IF HAZARD EXISTS
	MONITOR WELL	30 WELLS		# MONITOR WELLS REQD. AT LEACH DUMP IF HAZARD EXISTS
	MONITOR WELL	36 WELLS		# MONITOR WELLS REQD. AT TAILINGS POND IF HAZARD EXISTS
	CONCENTRATES	740000 TONS/YEAR		FROM Cu AND CONCENTRATE GRADE
	MILL FEED	29790660 TONS/YEAR		FROM MATERIAL BALANCE
	WT. TAILINGS	29050660 TONS/YEAR		CALCULATED FROM CONCENTRATE THROUGHPUT
	PRODUCTION	205000 TONS/YEAR		TOTAL ANNUAL Cu CAPACITY

## ECONOMIC INPUTS:

INPUT	VALUE	UNITS	REMARKS
DEPRECIATION	15 YEARS		ASSUMED DEPRECIATION LIFETIME
INTEREST RATE	9 PERCENT		CRA ASSUMPTION
INT. FRACTION	0.09 FRACTION		CONVERSION OF INTEREST RATE TO DECIMAL
CRF	0.12406 FRACTION		STD. COMPUTATION OF CAPITAL RECOVERY FACTOR
MINE HORIZON	15 YEARS		ASSUMPTION IN CRA REPORT

PREPARED 24-Mar-86

PV CLOSURE	0.27454 FRACTION	PRESENT VALUE FRACTION FOR CLOSURE COSTS
PV ANNUITY	10.2737 FACTOR	PRESENT VALUE OF 30 YR. POST-CL. ANNUITY FOR PRESENT WASTE
PV POST-CL	2.8205 FACTOR	PRESENT VALUE OF 30 YR. POST-CL. ANNUITY FOR FUTURE WASTE
PERMIT COST	\$3.00 MILLIONS	DATA IN CRA REPORT

# COST CALCULATIONS FOR EXISTING WASTES:

ITEM DESCRIPTION	ASSUMED IN THIS ANALYSIS (YES=1.0, NO=0)	ESTIMATED CAPITAL COST (\$MILLIONS)	ESTIMATED ANNUAL COST (\$MILLIONS)	CRA REPORT TABLE REFERENCE	REMARKS/BASIS
SITE SECURITY-MINE WASTE	0	\$0.000	\$0.000	TABLE A-2,1	OVERBURDEN AND ORE NOT HAZARDOUS
SITE SECURITY-LEACH DUMP	1	\$1.513	\$0.076	TABLE A-2,1	WASTE ASSUMED TO BE LISTED
SITE SECURITY-TAILINGS	1	\$1.782	\$0.089	TABLE A-2,1	TAILINGS HAVE ACID-FORMATION POTENTIAL
LEACHATE COLLECTION MINE	0	\$0.000	\$0.000	TABLE A-2,4.1	ASSUMED UNNECESSARY
LEACHATE COLLECTION LEACH	0	\$0.000	\$0.000	TABLE A-2,4.1	ASSUMED PRESENT IN BASE CASE
LEACHATE COLLECTION TAIL.	1	\$1.213	\$0.061	TABLE A-2,4.1	REQD. PER TABLE 3-5
LEACHATE TREATMENT MINE	0	\$0.000	\$0.000	TABLE A-2,4.1	
LEACHATE TREATMENT LEACH	1	\$1.481	\$0.405	TABLE A-2,4.1	REQD. PER TABLE 3-5
LEACHATE TREATMENT TAIL.	1	\$2.632	\$0.830	TABLE A-2,4.1	REQD. PER TABLE 3-5
MONITORING WELLS MINE	0	\$0.000	\$0.000	TABLE A-2,5	ASSUMED UNNECESSARY
MONITORING WELLS LEACH	1	\$0.150	\$0.193	TABLE A-2,5	REQUIRED
MONITORING WELLS TAILINGS	1	\$0.180	\$0.231	TABLE A-2,5	REQUIRED
RUN-ON SYSTEM M-WASTE	1	\$0.555	\$0.028	TABLE A-2,6	REQD. FOR ORE PILES ONLY
RUN-OFF-SYSTEM M-WASTE	1	\$0.555	\$0.028	TABLE A-2,7	REQD. FOR ORE PILES ONLY
INTERCEPTOR WELLS MINE	0	\$0.000	\$0.000	TABLE A-2,9	UNNECESSARY BECAUSE NOT HAZARD
INTERCEPTOR WELLS LEACH	1	\$5.984	\$1.593	TABLE A-2,9	ASSUMED TO BE REQUIRED
INTERCEPTOR WELLS TAIL.	1	\$9.878	\$3.008	TABLE A-2,9	ASSUMED TO BE REQUIRED
CLOSURE MINE WASTE	0	\$0.000	\$0.000	TABLE A-2,10	MINE WASTE NOT HAZARDOUS
CLOSURE LEACH	1	\$253.200	\$0.000	TABLE A-2,10	SPENT AT BEGINING
CLOSURE TAILINGS	1	\$660.000	\$0.000	TABLE A-2,10	SPENT AT BEGINING
POST-CLOSURE	1	\$0.000	\$14.307	TABLE A-2,11	SPENT FOR 30 YEARS FROM START

TOTAL OF ABOVE COSTS (\$MILLIONS)	\$939.123	\$14.307 ANNUAL COSTS ARE POST-CLOSURE ONLY
LIFETIME (\$MILLIONS)		\$1,368.33 INCLUDES CAPITAL AND 30 YR. POST-CLOSURE
ANNUALIZED COSTS (\$MILLIONS)		\$134.741 EVALUATED USING ABOVE ECONOMIC ASSUMPTIONS
UNITIZED COST CENTS/LB @ CAPACITY		32.86 INCLUDES OPERATING AND ANNUALIZED CAPITAL COSTS
@ NOMINAL UTILIZATION		41.08 APPROXIMATE VALUE

# COST CALCULATIONS FOR FUTURE WASTES:

ITEM DESCRIPTION	ASSUMED IN THIS ANALYSIS (YES=1.0, NO=0)	ESTIMATED CAPITAL COST (\$MILLIONS)	ESTIMATED ANNUAL COST (\$MILLIONS)	CRA REPORT TABLE REFERENCE	REMARKS/BASIS
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SITE SECURITY-MINE WASTE	0	\$0.000	\$0.000 TABLE A-2,1 OVERBURDEN AND ORE NOT HAZARDOUS
SITE SECURITY-LEACH DUMP	1	\$1.513	\$0.076 TABLE A-2,1 WASTE ASSUMED TO BE LISTED
SITE SECURITY-TAILINGS	1	\$1.782	\$0.089 TABLE A-2,1 TAILINGS HAVE ACID-FORMATION POTENTIAL
PERMITTING	1	\$3.000	\$0.000 TABLE A-1 REQD.
IMPERMEABLE LINER-M-WASTE	0	\$0.000	\$0.000 TABLE A-2,3.1OVERBURDEN AND ORE NOT HAZARDOUS
IMPERMEABLE LINER-LEACH	1	\$118.160	\$0.000 TABLE A-2,3.1WASTE ASSUMED TO BE LISTED
IMPERMEABLE LINER-TAILINGS	1	\$522.500	\$0.000 TABLE A-2,3.3ASSUMED
LEACHATE COLLECTION MINE	0	\$0.000	\$0.000 TABLE A-2,4.1UNNECESSARY
LEACHATE COLLECTION LEACH	0	\$0.000	\$0.000 TABLE A-2,4.1UNNECESSARY FOR FUTURE WASTES IF LINED
LEACHATE COLLECTION TAIL.	0	\$0.000	\$0.000 TABLE A-2,4.1UNNECESSARY FOR FUTURE WASTES IF LINED
LEACHATE TREATMENT MINE	0	\$0.000	\$0.000 TABLE A-2,4.1UNNECESSARY FOR FUTURE WASTES IF LINED
LEACHATE TREATMENT LEACH	0	\$0.000	\$0.000 TABLE A-2,4.1UNNECESSARY FOR FUTURE WASTES IF LINED
LEACHATE TREATMENT TAIL.	0	\$0.000	\$0.000 TABLE A-2,4.1UNNECESSARY FOR FUTURE WASTES IF LINED
MONITORING WELLS MINE	0	\$0.000	\$0.000 TABLE A-2,5 ASSUMED UNNECESSARY
MONITORING WELLS LEACH	1	\$0.150	\$0.193 TABLE A-2,5 REQUIRED
MONITORING WELLS TAILINGS	1	\$0.180	\$0.231 TABLE A-2,5 REQUIRED
RUN-ON SYSTEM M-WASTE	1	\$0.555	\$0.028 TABLE A-2,6 REQD. FOR ORE PILES ONLY
RUN-OFF-SYSTEM M-WASTE	1	\$0.555	\$0.028 TABLE A-2,7 REQD. FOR ORE PILES ONLY
TAILINGS TREATMENT	0	\$0.000	\$0.000 TABLE A-2,8 DELETED FOR THIS RUN
INTERCEPTOR WELLS MINE	0	\$0.000	\$0.000 TABLE A-2,9
INTERCEPTOR WELLS LEACH	0	\$0.000	\$0.000 TABLE A-2,9 PER STATEMENT ON p-21
INTERCEPTOR WELLS TAIL.	0	\$0.000	\$0.000 TABLE A-2,9 PER STATEMENT ON p-21
CLOSURE MINE WASTE	0	\$0.000	\$0.000 TABLE A-2,10 MINE WASTE NOT HAZARDOUS
CLOSURE LEACH	1	\$284.850	\$0.000 TABLE A-2,10 SPENT AT END OF MINE HORIZON
CLOSURE TAILINGS	1	\$742.500	\$0.000 TABLE A-2,10 SPENT AT END OF MINE HORIZON
POST-CLOSURE	1	\$0.000	\$10.787 TABLE A-2,11 SPENT AFTER END OF MINE LIFE

TOTAL OF ABOVE COSTS (\$MILLIONS)	\$1,675.745	\$11.432 TOTAL ANNUAL COSTS INCLUDE POST-CLOSURE
LIFETIME (\$MILLIONS)		ANNUAL COSTS WHICH NEED TO BE DISCOUNTED
		\$2,009.04 INCLUDES 15 YR. OPNS. & 30 YR. POST-CLOSURE
ANNUALIZED COSTS (\$MILLIONS)		\$119.849 EVALUATED USING ABOVE ECONOMIC ASSUMPTIONS
UNITIZED COST CENTS/LB @ CAPACITY		29.23 INCLUDES OPERATING AND ANNUALIZED CAPITAL COSTS
@ NOMINAL UTILIZATION		36.54 APPROXIMATE VALUE

GRAND TOTAL: CAPITAL COSTS (\$MILLIONS)	\$2,614.87 FOR PRESENT AND FUTURE WASTES
LIFETIME COSTS(\$MILLIONS)	\$3,377.37 INCLUDED CAPITAL, OPERATIONS AND POST-CLOSURE
ANNUALIZED COSTS (\$MILLIONS)	\$254.59 EVALUATED USING ABOVE ECONOMIC ASSUMPTIONS
UNITIZED COST CENTS/LB @ CAPACITY	62.10 INCLUDES OPERATING AND ANNUALIZED CAPITAL COSTS
@ NOMINAL UTILIZATION	77.62 APPROXIMATE VALUE